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09/982,086	10/19/2001	Jeong-kwan Lee	1293.1270	6758

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STAAS & HALSEY LLP
SUITE 700
1201 NEW YORK AVENUE, N.W.
WASHINGTON, DC 20005

EXAMINER	
GEBREMARIAM, SAMUEL A	

ART UNIT	PAPER NUMBER
2811	

DATE MAILED: 11/16/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	09/982,086	LEE ET AL.	
	Examiner	Art Unit	
	Samuel A Gebremariam	2811	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *18 August 2004*.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-64* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-64* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☒ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

Claim Rejections - 35 USC § 103

1. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Claims 1-3, 5-9, 11-20 and 22-64 are rejected under 35 U.S.C. 103(a) as being unpatentable over admitted prior art, Jiang et al. US patent No. 5,966,399 and in view of Webb US patent No. 6,051,848.

Regarding claim 1 admitted prior art teaches a vertical cavity surface emitting laser (VCSEL) comprising: a substrate (10); a lower reflector formed on the substrate (11); an active layer (12) formed on the lower reflector, generating light by a recombination of electrons and holes; an upper reflector (14) formed on the active layer comprising a lower reflectivity than that of the lower reflector, an upper electrode formed above the upper reflector excluding the window region; and a lower electrode formed underneath the substrate.

Admitted prior art does not explicitly teach a micro-lens comprising a single convex surface disposed in a window region having an arch extending through the entire window region through which the laser beam is emitted; a lens layer formed on the upper reflector with a transparent material transmitting a laser beam, the lens layer comprising the micro-lens.

Jiang teaches (fig. 1) a VCSEL with integrated lens with micro-lens region (44) comprising a single convex surface (central portion of 44) and lens layer (region of lens where light 12 is not coming out) on the upper reflector region (22).

Furthermore Webb teaches the formation of lens region (22) having an arch extending through the lens window region (fig. 2) in the structure of forming a VCSEL device (24).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to incorporate the microlens portion of Jiang's device into the structure of admitted prior art in order to focus and/or collimate laser emission (column 6, lines 57-63). Furthermore more it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the lens structure of Jiang by forming a single lens having an arch extending through the entire window as taught by Webb in order to reduce the processing step of forming a single lens by etching.

Regarding claim 2 admitted prior art teaches substantially the entire structure of claim 1 above except explicitly stating that the VCSEL satisfies a following relationship: $f = Rxn1/(n2-n1)$ where f is a distance along an optical axis from a light generating region of the active layer to a vertex of the micro-lens, R is a radius of curvature of the micro-lens, n1 is an effective refractive index of a medium on an optical path between the light generating region and the lens layer, and n2 is a refractive index of a region towards which a light is emitted through the micro-lens.

The formula above is a well known in the art. Since the combined structure of admitted prior art, Jiang and Webb results in a structure identical to the claimed invention the VCSEL structure inherently satisfies the above relationship.

Regarding claim 3, admitted prior art teaches substantially the entire structure of claim 1 above including a high-resistance region (13) between the upper and lower reflectors relatively close to the active layer, the high-resistance region having an aperture at a center thereof through which a current flows (fig. 1, admitted prior art).

Regarding claims 5 and 11 admitted prior art teaches substantially the entire structure of claim 1 except explicitly stating that the micro-lens is formed by diffusion-limited etching.

The limitation that the micro-lens is formed by diffusion-limited etching is considered a product-by-process claim. "[E]ven though product-by process claims are limited by and defined by the process, determination of patentability is based on the product itself. The patentability of a product does not depend on its method of production. If the product in the product-by-process claim is the same as or obvious from a product of the prior art, the claim is unpatentable even though the prior product was made by a different process." *In re Thorpe*, 777 F.2d 695, 698, 227 USPQ 964, 966 (Fed. Cir. 1985).

Regarding claims 6 and 7, admitted prior art teaches substantially the entire structure of claims 1-3 except explicitly stating the window region comprises a maximum width smaller than a size of light generated in the active layer emitted towards the window region, satisfying a Fraunhofer diffraction condition occurring in the window

region is offset by a focusing power of the micro-lens, where the maximum width of the window region D and a focal length f of the micro-lens satisfy a relation:

$D= (2x1.22\lambda f)^{1/2}$ where k, is a wavelength of the laser beam emitted from the VCSEL.

Since the combined structure of admitted prior art, Jiang and Webb is identical to the claimed device the combined structure satisfies the Fraunhofer diffraction condition as claimed.

Regarding claims 8 and 9, admitted prior art teaches substantially the entire structure of claim 1 except explicitly stating that the high-resistance region according to claims 6 and 7, between the upper and lower reflectors, relatively close to the active layer, the high-resistance region comprising an aperture at a center thereof through which a current flows, the aperture of the high-resistance region comprising a maximum width greater than or approximately equal to the maximum width of the window region.

Parameters such as width in the art of semiconductor manufacturing process are subject to routine experimentation and optimization to achieve the desired device characteristics.

It would have been obvious to one of ordinary skill to in the art at the time the invention was made to make the high-resistance region comprising a maximum width greater than or approximately equal to the maximum width of the window as claimed.

Regarding claims 12-15, 16, 17-21 and 22, admitted prior art teaches substantially the entire structure of claims 1-4, 5, 6-10 and 11, except explicitly stating

that the substrate is now used for transmitting the laser beam and the substrate comprises the microlens.

It would have been obvious to one of ordinary skill in the art at the time the invention was made to invert the combined structure of admitted prior art and Jiang and form the lens and micro-lens in the lower portion of the combined structure, since it has been held that rearranging parts of the invention involves only routine skill in the art. In re Japikse, 86 USPQ 70.

Regarding claim 23-26 admitted prior art teaches substantially the entire structure of claims 1-3, 5, 6-9 including a microlens integrally formed on a laser beam-emitting surface of the VCSEL emitting a parallel light beam and disposed in a window region through which the light beam is emitted; a lens layer comprising the microlens and formed on the laser beam emitting surface of the VCSEL (Jiang, fig. 1).

Regarding claim 27 admitted prior art teaches substantially the entire structure of claims 1-3, 5, 6-9 and 23 except explicitly stating that the aperture is small where the current applied through the upper electrode passes a region on the active layer and the light beam is generated in a dot-sized region of the active layer.

Parameters such as size of the aperture and the area of the light beam generated on the active layer in the art of semiconductor manufacturing process are subject to routine experimentation and optimization to achieve the desired device characteristics.

It would have been obvious to one of ordinary skill to in the art at the time the invention was made to vary the size of the aperture and the light beam area on the active layer as claimed.

Regarding claim 28, admitted prior art teaches substantially the entire claimed structure of claims 1-3, 5, 6-9 and 23 including the micro-lens lies along a central optical axis of the light beam emitted from the VCSEL (fig. 1, Jiang).

Regarding claims 29-31 and 32, admitted prior art teaches substantially the entire claimed structure of claims 1-4, 5, 6-10 and 23 including the lower reflector, the active layer, and the upper reflector are sequentially stacked on the substrate, the lower reflector and the upper reflector are formed of alternating semiconductor compounds comprising different refractive indexes and the lower reflector is doped with the same n-type impurities and the upper reflector is doped with p-type impurities (fig. 1, page 2, paragraph 5, prior art).

Regarding claim 33, admitted prior art teaches substantially the entire claimed structure of claims 1-3, 5, 6-9 and 23 including the active layer is formed of GaAs according to a wavelength of the light beam (fig. 1, Jiang, col. 5, lines 41-64).

Regarding claims 34 and 36, admitted prior art teaches substantially the entire claimed structure of claims 1-3, 5, 6-9 and 23 except explicitly stating that the high-resistance region comprising an aperture at a center thereof through which current applied through the upper electrode flows and high-resistance region is formed by implantations of ions or by selective oxidation in a region of the upper reflector and the micro-lens comprises a convex surface formed by diffusion-limited etching.

The limitations that the high resistance as claimed is formed by implantation of ions or selective oxidation and the micro-lens is formed by diffusion-limited etching are considered a product-by-process claim. "[E]ven though product-by process claims are limited by and defined by the process, determination of patentability is based on the product itself. The patentability of a product does not depend on its method of production. If the product in the product-by-process claim is the same as or obvious from a product of the prior art, the claim is unpatentable even though the prior product was made by a different process." *In re Thorpe*, 777 F.2d 695, 698, 227 USPQ 964, 966 (Fed. Cir. 1985).

Regarding claim 37 admitted prior art teaches substantially the entire claimed structure of claims 1-3, 5, 6-9 and 23 including the upper electrode is formed on top of the lens layer (fig. 1, Jiang).

Regarding claims 38–40 admitted prior art teaches substantially the entire claimed structure of claims 1-3, 5, 6-9 and 23 except explicitly stating that the distance along an optical axis from the light generating region to a vertex of the micro-lens is equal to a focal length of the micro-lens where the VCSEL satisfies a following relationship: f =Rxn1/(n2-n1) where f is a distance along an optical axis from the light generating region to the vertex of the micro-lens, R is a radius of curvature of the micro-lens, n1 is an effective refractive index of a medium on an optical path between the light generating region and the lens layer, and n2 is a refractive index of a region toward which the light beam is emitted through the micro-lens; and the VCSEL also satisfies a following relationship: nl/Sl+n2/S2=(n2-nl)/R where S1 is a distance from the light

generating region of the active layer to a vertex of the micro-lens on the optical axis, S2 is a distance from the vertex of the micro-lens to a second focal point of the micro-lens, n1 is an effective refractive index of the medium from the upper reflector and the lens layer, and n2 is a refractive index of a region toward which the light beam emitted through the micro-lens travels.

The formulas above are well known in the art. Since the combined structure of admitted prior art, Jiang and Webb results in a structure identical to the claimed invention the VCSEL structure inherently satisfies the above relationships.

With regards to the limitation that the distance along an optical axis from the light-generating region to a vertex of the micro-lens is equal to a focal length of the micro-lens is within the scope of one having ordinary skill in the art to find the optimal distance as claimed through obvious and routine experimentation.

Regarding claim 41 admitted prior art teaches substantially the entire claimed structure of claims 1-3, 5, 6-9 and 23 above except explicitly stating a forward biased current is applied to the micro-lens built-in VCSEL through the upper and lower electrodes, the light beam comprising a particular wavelength through laser oscillation is transmitted through the upper reflector and the lens layer and is condensed by the micro-lens and emitted as the parallel laser beam.

The above claimed limitation is the way VCSEL fitted with a micro-lens operates under normal operation condition. Since the claimed structure is identical to the combined structure of admitted prior art, Jiang and Webb it inherently operates as claimed above.

Regarding claim 42-46 admitted prior art teaches substantially the entire claimed structure of claims 1-3, 5, 6-9, 12 and 23 above including the VCSEL is a top-emitting type VCSEL (fig. 1, Jiang).

The combined teaching of admitted prior art, Jiang and Webb does not explicitly teach the limitation that the micro-lens is formed in the window region of the substrate through which the light beam is condensed and emitted.

It would have been obvious to one of ordinary skill in the art at the time the invention was made to invert the combined structure of admitted prior art and Jiang and form the lens and micro-lens in the lower portion of the combined structure, since it has been held that rearranging parts of the invention involves only routine skill in the art. In re Japikse, 86 USPQ 70.

Regarding claims 47-48 admitted prior art teaches substantially the entire claimed structure of claims 1-4, 5, 6-10, 12 and 23 above including that when a number of stacked layers of the lower reflector is smaller than that of the upper reflector, the reflectivity of the lower reflector is lower than that of the upper reflector and most of the laser beam is emitted through the lower reflector.

The above limitation is inherent characteristics of a reflector structure. Therefore the combined structure of admitted prior art, Jiang and Webb have the claimed characteristic of the reflectors inherently.

Regarding claims 49-50, the combined teaching of admitted prior art, Shimada and Lee teaches substantially the entire claimed structure of claims 1-4, 5, 6-10, 12 and

23 above including the lower reflector and the upper reflector are formed of alternating semiconductor compounds comprising different refractive indexes (fig. 1, prior art).

Since the combined structure of admitted prior art and Jiang is identical to the claimed structure it inherently have the claimed property.

Regarding claim 51 admitted prior art teaches substantially the entire claimed structure of claims 1-3, 5, 6-9, 12 and 23 above except explicitly stating that the VCSEL satisfies a following relationship: f'= R'xn1'/(n2'-n1') where R' is a radius of curvature of the micro-lens, n1' is a effective refractive index of a medium along an optical path between the light generating region of the active layer and the micro-lens, and n2' is a refractive index of a region toward which the light beam emits through the micro-lens, f' is a distance from the light generating region to a vertex of the micro-lens along the optical axis.

The formula above is well known in the art. Since the combined structure of admitted prior art, Webb and Jiang results in a structure that is identical to the claimed invention the VCSEL structure inherently satisfies the relationship above.

Regarding claims 52 and 53 admitted prior art teaches substantially the entire claimed structure of claims 1-3, 5, 6-9, 12 and 23 above except explicitly stating that a forward biased current is applied to the micro-lens built-in VCSEL through the upper and lower electrodes, a laser beam comprising a particular wavelength through laser oscillation is transmitted through the lower reflector and the substrate and is condensed by the micro-lens and emitted as the parallel laser beam and the VCSEL is a bottom-emitting type VCSEL.

The above claimed limitation is the way VCSEL fitted with a micro-lens at the bottom operates under normal operation condition. Since the claimed structure is identical to the combined structure of admitted prior art, Jiang and Webb it inherently operates as claimed above.

Regarding claims 54 and 55 admitted prior art teaches substantially the entire claimed structure of claims 1-3, 5, 6-9, 12 and 23 above except explicitly stating that an upper reflector comprising a relatively lower reflectivity than that of the lower reflector.

Parameters such as reflectivity and size are variables that are subject to optimization through routine experimentation.

It would have been obvious to one of ordinary skill to in the art at the time the invention was made to vary the reflectivity as claimed in order to satisfy the Fraunhofer diffraction condition.

Regarding claims 56, 57 and 61 admitted prior art teaches substantially the entire claimed structure of claims 1-4, 5, 6-10, 12, 23 and 54 above except explicitly stating that the Fraunhofer diffraction condition of the window is offset by a focusing power of the micro-lens so that a parallel laser beam is emitted through the micro-lens the diameter D of the window and a focal length f of the micro-lens satisfy a following relationship: $D = (2 \times 1.22 \lambda f)^{1/2}$ where λ is a wavelength of the light beam emitted from the VCSEL and also a following relationship:

$N_f = D^2/\lambda d \ll 1$; where N_f is a Fresnel number, λ, is a wavelength of the light beam emitted from the VCSEL, D is the diameter of the window, and d is a distance from the window to an observing plane, which is one focal point of the micro-lens.

Since the combined structure of admitted prior art, Webb and Jiang is identical to the claimed device the combined structure satisfies the Fraunhofer diffraction conditions as claimed.

Regarding claim 58, admitted prior art teaches substantially the entire claimed structure of claims 1-3, 5, 6-9, 12, 23 and 54 above including the high-resistance region between the upper and lower reflectors relatively close to the active layer, the high-resistance region comprises an aperture at the center thereof through which a current flows (fig. 1).

Regarding claim 59 admitted prior art substantially the entire claimed structure of claims 1-3, 5, 6-9, 12, 23 and 54 above except explicitly stating that the diameter of the window is smaller than or approximately equal to a diameter of the aperture of the high-resistance region.

Parameters such as diameter and radius are variables that are subject to optimization through routine experimentation.

It would have been obvious to one of ordinary skill to in the art at the time the invention was made to vary the diameter of the window as claimed.

Regarding claims 60 and 62 admitted prior art teaches substantially the entire claimed structure of claims 1-3, 5, 6-9, 12 and 23 above including the window and the micro-lens are positioned on a same and the micro-lens and the window are positioned on a same plane (fig. 1, Jiang).

Regarding claim 63 admitted prior art teaches substantially the entire claimed structure of claims 1-3, 5, 6-9, 12, 23 and 54 above except explicitly stating that when

the micro-lens and the window are positioned on a same plane and only a O th -order diffracted beam comprising a high intensity is considered, a radius RS of the O th-order diffracted beam satisfies a following relationship: $R_s = 1.22\lambda d/ D$ where λ, is a wavelength of the light beam emitted from the VCSEL, D is the diameter of the window, and d is a distance from the window to an observing plane.

Since the combined structure of admitted prior art and Jiang is identical to the claimed device the combined structure satisfies the above relationship as claimed.

Regarding claim 64 admitted prior art teaches substantially the entire claimed structure of claims 1-3, 5, 6-9, 12, 23 and 54 above including the VCSEL is a top-emitting type VCSEL (fig. 1, Jiang).

Claims 4,10 and 21, are rejected under 35 U.S.C. 103(a) as being unpatentable over admitted prior art, Jiang, Webb and in view of Peake et al. US patent No. 6,122,109.

Admitted prior art teaches substantially the entire structure of claims 1, 6 and 12 above except explicitly stating that the lens layer is formed of a material comprising at least one of silicon and a III-V compound semiconductor, wherein the III-V compound semiconductor comprises one of indium phosphide (InP), gallium arsenide (GaAs), indium arsenide (InAs), gallium phosphide (GaP), indium gallium phosphide (InGaP), indium gallium arsenide (InGaAs), and aluminum gallium arsenide (AlGaAs), the material comprising a relatively large bandgap to a wavelength of the laser beam so as not to absorb the laser beam.

It is conventional and also taught by Peake forming a microlens layer using GaAs (col. 6, line 46-53).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to incorporate the microlens layer formed of GaAs taught by Peake in the structure of admitted prior art, Webb and Jiang in order to form VCSEL.

Response to Arguments

2. Applicant's arguments with respect to claims 1-64 have been considered but are persuasive. Applicant argues that the lens pattern of Webb is so large that it is incompatible the lens structure of Jiang. The reason combine Webb in the structure Jiang is to illustrate that forming a convex lens with an arch that extends along the entire window is conventional in the art. Furthermore Webb teaches a VCSEL device that is fitted with a single convex surface having an arch extending through the entire window region. Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the lens structure of Jiang by forming a single lens having an arch extending through the entire window as taught by Webb in order to reduce the processing step of forming a single lens by etching.

Conclusion

3. **THIS ACTION IS MADE FINAL.** Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not

mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Samuel Admassu Gebremariam whose telephone number is 571 272 1653. The examiner can normally be reached on 8:00am-4:30pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Eddie Lee can be reached on (571) 272-1732. The fax phone numbers for the organization where this application or proceeding is assigned are (703) 872-9306 for regular communications and (703) 872-9306 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is (703) 308-0956.

Samuel Admassu Gebremariam
October 28, 2004

EDDIE LEE
SUPERVISORY PATENT EXAMINER
TECHNOLOGY CENTER 2800